

# National Weather Service Summer 2006 Outlook

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## The Forecast:

The official National Weather Service forecast for the Summer of 2006 for all of Southwest Lower Michigan calls for equal chances (EC) of above, below, and near normal temperatures and precipitation.

## Normal:

Normals are calculated from the data recorded from 1971 to 2000. The following table represents the normal data through the summer period for Grand Rapids, Lansing and Muskegon.

|   | GRAND RAPIDS | MUSKEGON | LANSING |
|---|--------------|----------|---------|
| <b>TEMPERATURE:</b><br>(Avg. June – August)   |              |          |         |
| <b>HIGH:</b>                                  | 80F          | 78F      | 80F     |
| <b>LOW:</b>                                   | 58F          | 58F      | 57F     |
| <b>MEAN:</b>                                  | 69F          | 68F      | 68F     |
| <b># OF DAYS</b>                              |              |          |         |
| <b>HIGH ABOVE 89F:</b>                        | 9.5          | 2.2      | 9.2     |
| <b>PRECIPITATION:</b><br>(Avg. June – August) |              |          |         |
|   | 11.01"       | 7.86"    | 8.76"   |

## FORECAST REASONING

The summer forecast is based on the interplay of **five primary factors** which usually influence seasonal climate patterns over the United States and the rest of the globe. They are the **El Niño/Southern Oscillation (ENSO)**, the **Madden Julian Oscillation (MJO)**, **North Atlantic Oscillation (NAO)**, **soil moisture and ice cover** and the **climate trend over the previous 10 years**. ENSO is a tropical oscillation and has three phases: El Niño, La Niña and neutral. It has a period of approximately 7 years. The second factor, the MJO, is also a tropical oscillation. It has a 30 to 60 day oscillation period. Outside the tropics we find the third factor, the NAO. This and its close cousin, the Arctic Oscillation (AO) are extra tropical oscillations and influence the weather over North America, Europe and Northern Asia. The fourth factor is the soil moisture and ice cover. These influence the amount of warming possible from region to region. Wet soils and ice cover hinder the warming process, while dry soil accelerates the warming process. The fifth factor, the climate trend over the previous 10 years, adds local knowledge to the mix. Being able to understand and forecast the interplay of these factors is key to a successful long range forecast.

To help make the seasonal forecast, a combination of dynamic models and statistical tools were employed. The dynamical model output was compared to the output from the statistical tools. Forecasts like this have the highest confidence in areas where both the dynamic models and the statistical tools agree.

The latest data from mid April shows **ENSO** in its La Niña phase but is weakening rapidly. It is now forecast to be in the neutral state by early to mid summer. Typically it takes several months after La Niña ends for the atmosphere to respond completely to the change. This means that while La Niña may fade to ENSO neutral conditions by early summer, its effects on the weather will likely continue through a good part of this summer. La Niña typically results in weak polar jet stream wind speeds and consequently allows for more blocking of the upper air flow than does the El Niño phase. Warmer or colder weather will also persist over the same region for longer periods of time. We have already seen this tendency clearly during this past winter. Most of the month of December was very cold. That period of colder than normal temperatures was followed by a very long period of mostly warmer than normal temperatures. All of the months from January through April have averaged warmer than normal. This suggests that whatever patterns we fall into this summer will likely continue for some time. Beside more persistent weather patterns, La Niña is more favorable for the development of Atlantic hurricanes. The weaker upper level winds allow tropical systems to develop deeper and stronger circulations. The La Niña phase also diminishes **MJO** activity, which feeds on warm tropical waters.

Through the year, the **NAO** and its cousin, the AO, have the largest influence on west Michigan weather. During periods of the negative phase of the NAO and AO, west Michigan tends to have below normal temperatures. During the positive phase of the NAO and AO, west Michigan usually has warmer than normal temperatures. Again, La Niña allows for these phases to persist longer than they would if ENSO was neutral or positive (El Niño). The problem is, unlike ENSO which can persist for a year or more, the phase of the NAO can change weekly. While it is also true that during a particular season one phase tends to dominate the pattern, forecasting the phase three or more months ahead of time has yet to show statistical skill. In summary, this means that the phase of the NAO and AO cannot be forecast. However, changes in phase should be slower to occur.

The dynamical models, which include the multi-model ensembles, suggest the southern half of the United States is likely to have a warmer than normal summer. For the northern Midwest and the western Great Lakes, there was no clear signal. The same is true for the climate models that use statistical correlations to come up with forecasts for the likelihood of below normal, near normal or above normal temperatures.

The dynamic and statistical models all suggest wetter than normal conditions to persist through the spring across the western Great Lakes and Northern Plains. However, by the summer months the strength of the signal

is not nearly as strong. Therefore, as with the temperature forecast, there is not a strong enough signal to indicate which of the three terciles is most likely.

The **climate trend tool** compares the data from the most recent 10 summers to the data from the preceding 30 summers to see if there is a statistically significant change in the climatic pattern of a region. For Southwest Lower Michigan, the trend is not statically significant for temperature. However, just southwest of the region, there is a significant trend toward warmer than normal summer temperatures. The climate trend tool also does not show a significant trend for precipitation.

The **soil moisture tool** (Figure 1) considers how wet the soils will be based on the precipitation forecast and current soil moisture conditions. As stated before, wet soils heat more slowly than do dry soils. The sun's energy must first be used to evaporate the water in the soil before any real heating of the soil can occur. The soil moisture tool shows a ten percent increase above the 33 1/3 percent normal distribution for above normal temperatures for Southwest Lower Michigan. There was however no significant trend for precipitation.

When all five of these factors are considered, the forecast ends up with a 33 1/3 percent chance of above normal, a 33 1/3 percent chance of near normal and a 33 1/3 percent chance of below normal values for both temperature and precipitation. We can say that based on the La Niña currently in place, whatever weather patterns form, they will be more persistent than usual.

Figures 2 and 3 show the CPC summer forecast for temperature and precipitation respectively. The links below give more detailed information on the forecast and information used to create it.

You can check the details on NCEP's web page at:

<http://www.cpc.ncep.noaa.gov/products/predictions/90day/>

Information about the current state of ENSO can be found at NCEP's ENSO page:

[http://www.cpc.ncep.noaa.gov/products/analysis\\_monitoring/enso\\_advisory/](http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/)

## LOCAL INFORMATION:

In forecasting the weather pattern for Southwest Lower Michigan (SWL) this summer, it is important to know the mean position of the polar jet stream. For example, last summer turned out to be exceptionally warm with most of Southwest Lower Michigan experiencing a top 10 warmest summer. This occurred in part because the Bermuda High was much larger than usual due to the unusually warm tropical Atlantic sea surface temperatures. That in turn caused the polar jet stream to be several hundred miles farther north (Figure 4). The northward shift meant Southwest Lower Michigan was deeper in the moist hot air longer than in a typical summer. If the jet stream is farther south as it was in 1992 (Figure 5), a cold summer with more frequent precipitation is seen. Figure 6 shows the typical position for the polar jet stream in the summer based on the 1971 to 2000 averages.

Another tool used to forecast seasonal weather is analogs. Analogues can be used to predict the likely mean position of the jet stream. The idea is that similar seasonal weather patterns result from similar polar jet stream patterns and these are influenced by persistent low frequency oscillation patterns. Since low frequency oscillations by their nature do not change quickly, that means once in a pattern, it is likely to last for several months.

The most significant aspects for SWL for the winter into early spring were the rather warm winter, mostly forced by a very warm January. Also of consequence are the ENSO state and the position of the polar vortex relative to its normal position. Since the state of ENSO influences the structure of the Pacific section of the polar jet stream, it will have an effect on the position of the jet stream relative to Michigan. Since the jet stream

is always on the south edge of the polar vortex, the position of the vortex relative to Southwest Lower Michigan is of greater importance to the weather. Forecasting the state of ENSO over a year in advance has shown significant skill in recent years as the computer models improve. On the other hand, forecasting the phase of the NAO or AO or the mean position of the polar jet stream more than a few weeks out is very difficult. This is why a composite analog approach is used to help us forecast the more difficult details. Details for this idea can be found on the CPC “Long Lead Briefing” web site at:

<http://www.cpc.ncep.noaa.gov/products/predictions/90day/tools/briefing/>  
then proceed to item 33, **Composites: AO/ENSO, ENSO** .

The reason we use a composite analog approach is that compositing the analog allows us to find a statistically significant correlation between a particular, stable upper air pattern and the climate pattern that follows it.

Before we get deeper into the composite analog method, we can still learn a little more from the interplay between the tropical oscillations and the extratropical oscillations that may help us forecast the summer weather for SWL. The CPC study referred to on the “Long Lead Briefing” web site allows us to find the most likely outcome of the seasonal temperature and precipitation anomaly based on a combination of the state of ENSO and the Arctic Oscillation. ENSO is forecast to be in a weak La Niña state into mid summer.

If La Niña does continue through the summer, a warm summer is the likely outcome for both the typical position of the jet stream and a farther north position. A more southerly position would result in a cool summer in southwest Michigan. The displaced north or south position of the jet stream typically means enhanced storminess, hence above normal rainfall. The reason a north or south displacement enhances rainfall for SWL is related to a more meridional upper air pattern which is related to a more active jet stream. The more normal position of the jet stream means an indeterminate forecast for the precipitation anomaly. That is due to a more zonal flow pattern which would result in an outcome that is more variable.

The neutral ENSO state is the second most likely outcome. If the neutral ENSO state were to happen, no matter what the state of the AO is, the temperature anomaly forecast for southwest Michigan for this summer would be the same, which is that any of the three outcomes are equally likely. The precipitation outcome is for a dry summer for a farther north position of the polar vortex, hence the jet stream, or a farther south position.

Based on all of the above information, our best forecast for temperature and precipitation in west Michigan is indeterminate. Since La Niña related conditions are expected to continue into mid summer, even if La Niña itself fades into history before that, and that two out of the three positions of the polar vortex result in above normal temperatures, and above normal rainfall, one could argue a warmer and wetter than normal outcome would be expected. However, owing to the lack of forecasting skill for the AO we are forced to conclude an indeterminate forecast is once again best.

Now let us consider our analog approach. Looking at all warm winters in southwest Michigan since 1950, it turns out of the 22 warm winters there were 12 warm summers, 6 near normal summers and 4 cold summers. That would favor a warm summer slightly. If we consider that we had a La Niña this past winter, it turns out that only 33% of those warm winters were followed by a warm summer. Half of those same summers, that is summers that followed a warm winter, when in a La Niña, had near normal summer temperatures. Only one summer in that pattern was colder than normal. That would seem to disfavor a cold summer. Figure 7 shows that near normal temperatures were the typical outcome. It should be pointed out that of those summers that followed a warm winter, with ENSO being in the La Niña state, 67% had La Niña continue through the summer. For the 33% of the cases when La Niña did not continue through the summer, none of those summers were warmer than normal. Adding this into all of the above information, we come back to an indeterminate forecast for temperature. However, we could argue to disfavor a cold summer, since regardless of the scenario, and given a La Niña in the winter with above normal temperatures for southwest Michigan, a cold summer was a rare outcome.

Looking at Figure 8, the precipitation anomaly for a summer that follows a warm La Niña winter, it is clear that above normal precipitation is the trend. This is similar to the trend for the spring precipitation (not shown).

Of the past 10 summers, 8 out of 10 have been drier than normal. This trend is strongest on the west side of Lower Michigan. Over on the east side of the state, the trend is for wetter summers.

One could also argue a wet forecast is favored based on the CPC study, La Niña ENSO summers tend to be wet except when there is also a mean position of the polar jet, in which case the forecast is indeterminate. This gives us a wet forecast based on our analog and a two out of three wet summer for La Niña (jet north or south of normal). Still, if ENSO were to fade to neutral by the summer, then the north or south position of the polar jet would give us a dry summer.

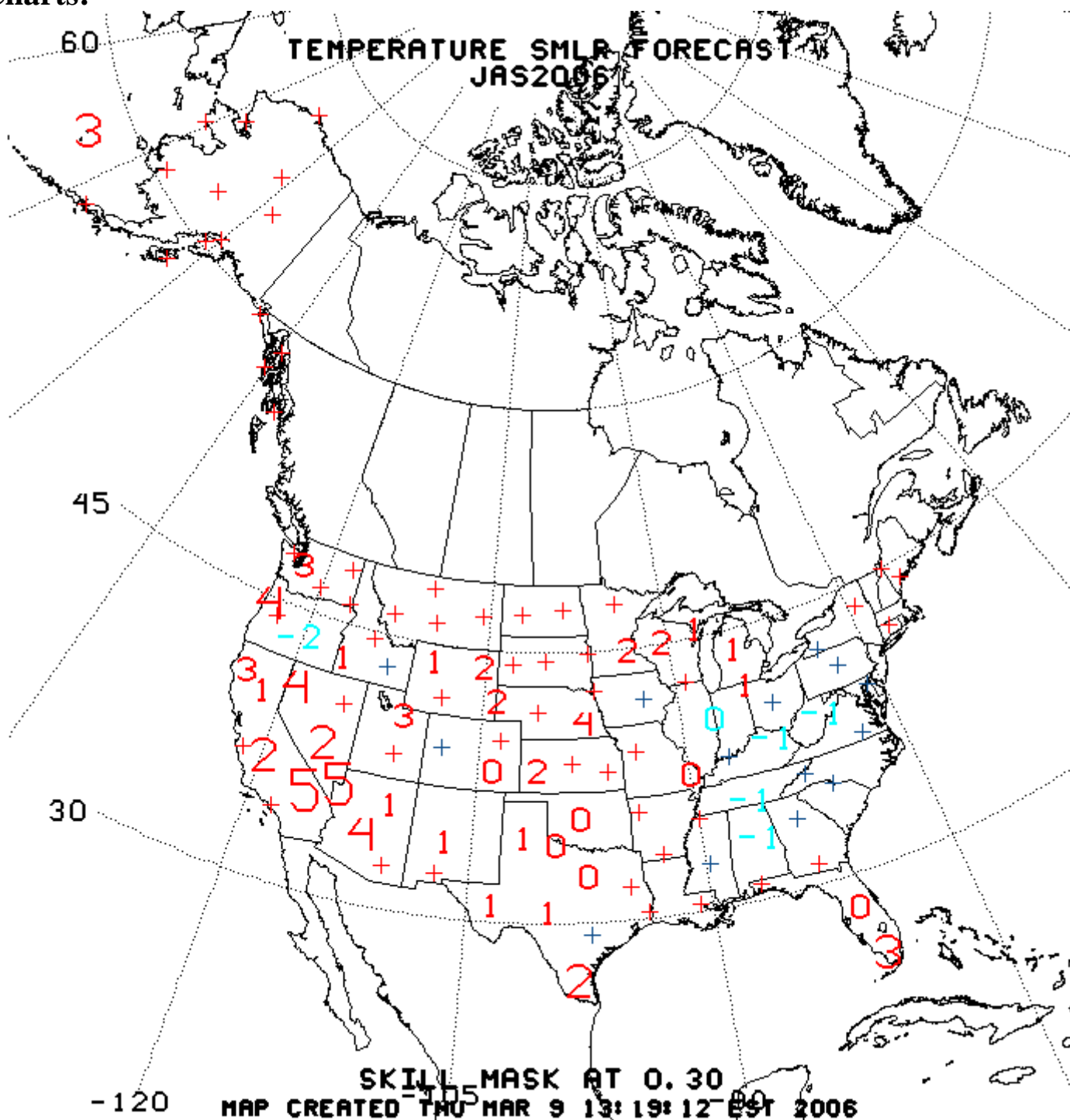
Putting this all together for the precipitation forecast, we get conflicting signals. This suggests an overall indeterminate forecast for summer precipitation.

## **SUMMARY:**

Putting the five influences together with the analogs for our summer temperature forecast, it would seem the cold outcome is slightly less favored, based mostly on our composite analog. However, the analog signal is too weak to give us a statistically significant forecast that actually favors one of the three outcomes clearly enough over the others.

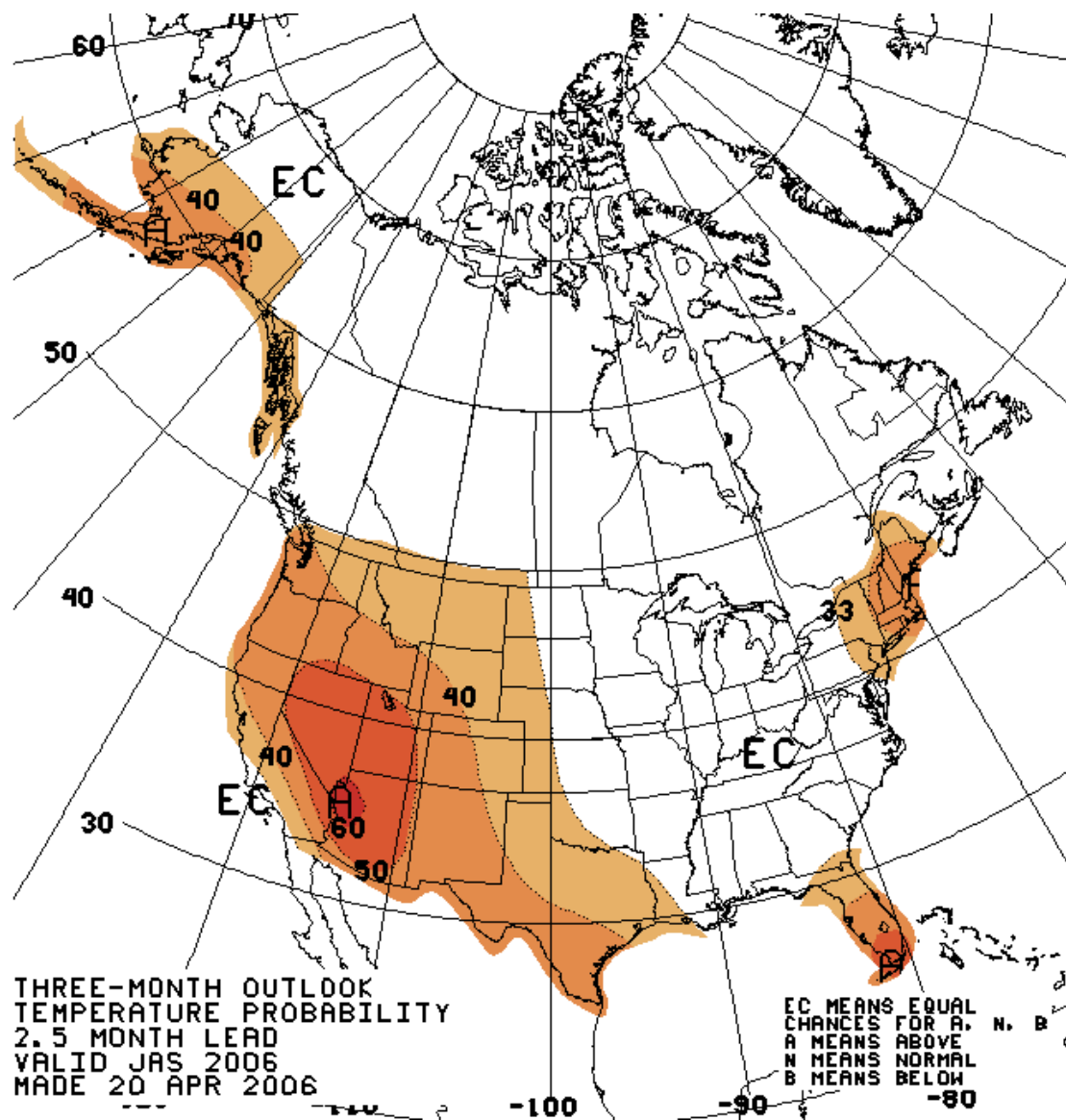
For the precipitation forecasts, the five influences did not give a statistically significant forecast for, wetter than normal, near normal or below normal precipitation. Our trend suggests a dry summer while the analog suggests a wet summer. Thus given conflicting signals, we do not have enough information to sway the forecast in a statistically significant direction toward either, wetter than normal, normal or below normal precipitation. Thus the indeterminate forecast for precipitation is our best forecast.

## Charts:

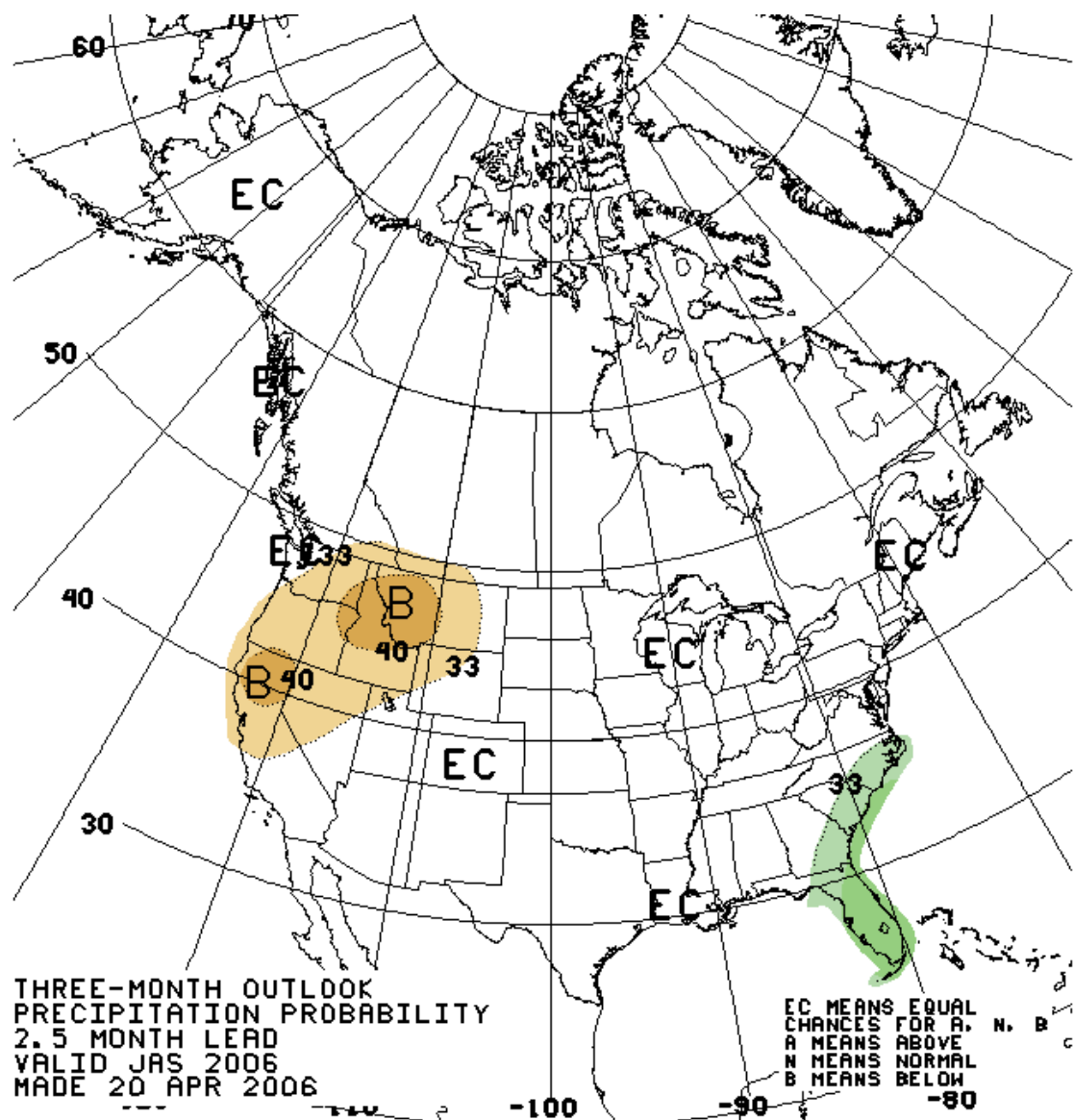


**Figure 1: Soil Moisture Tool Forecast for June July and August**

This chart shows the probability above 33 1/3 percent of the temperature for the three month period from June through August being above (red) or below (blue) normal. The big red and light blue numbers are 10 percent so A “3” means a 30 % increase above the 33 1/3 percent or a 63 1/3 percent chance of above normal temperatures. The 0.30 skill mask means numbers only show up on this chart if the forecast skill is better than 30 %.



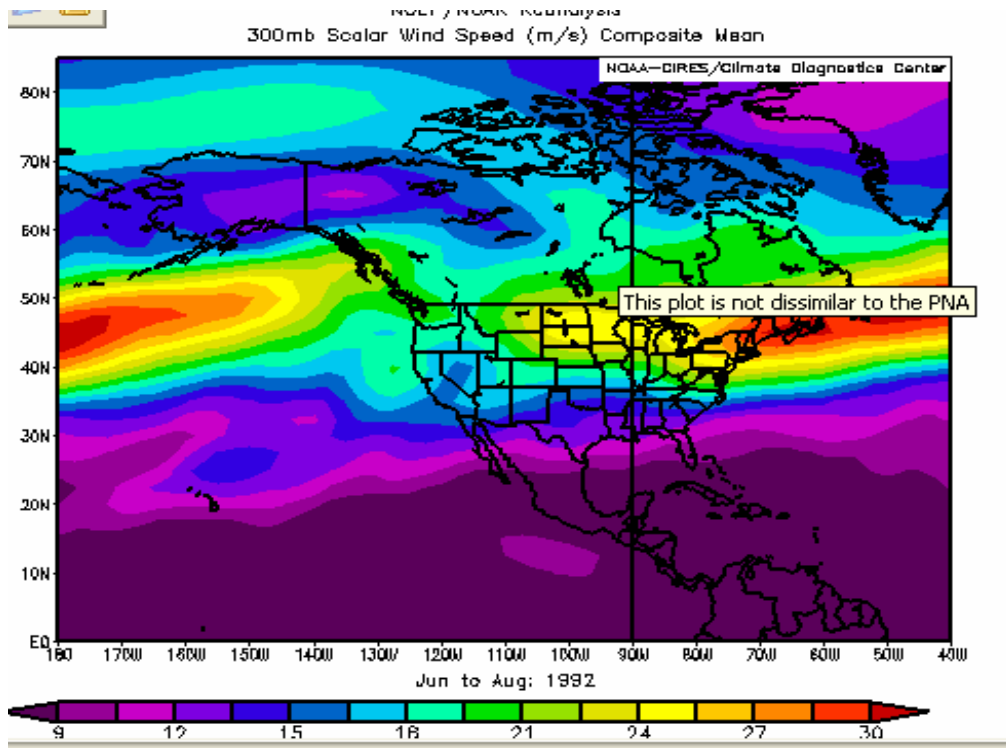
**Figure 2 CPC Summer Month Forecast for Temperature**



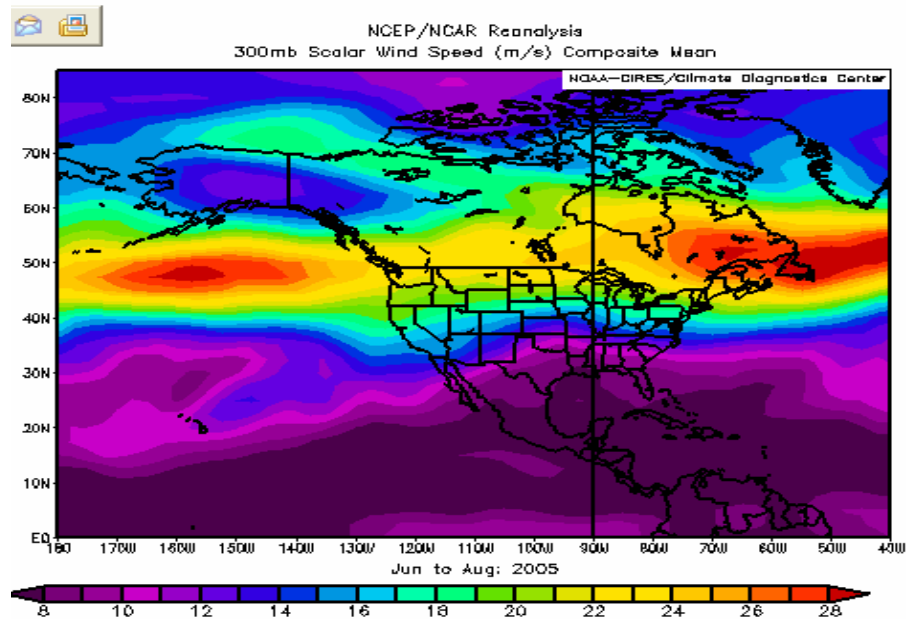
**Figure 3 CPC Summer Forecast for Precipitation**

## Summer Polar Jet Stream Location for Cold, Warm and then the typical summer

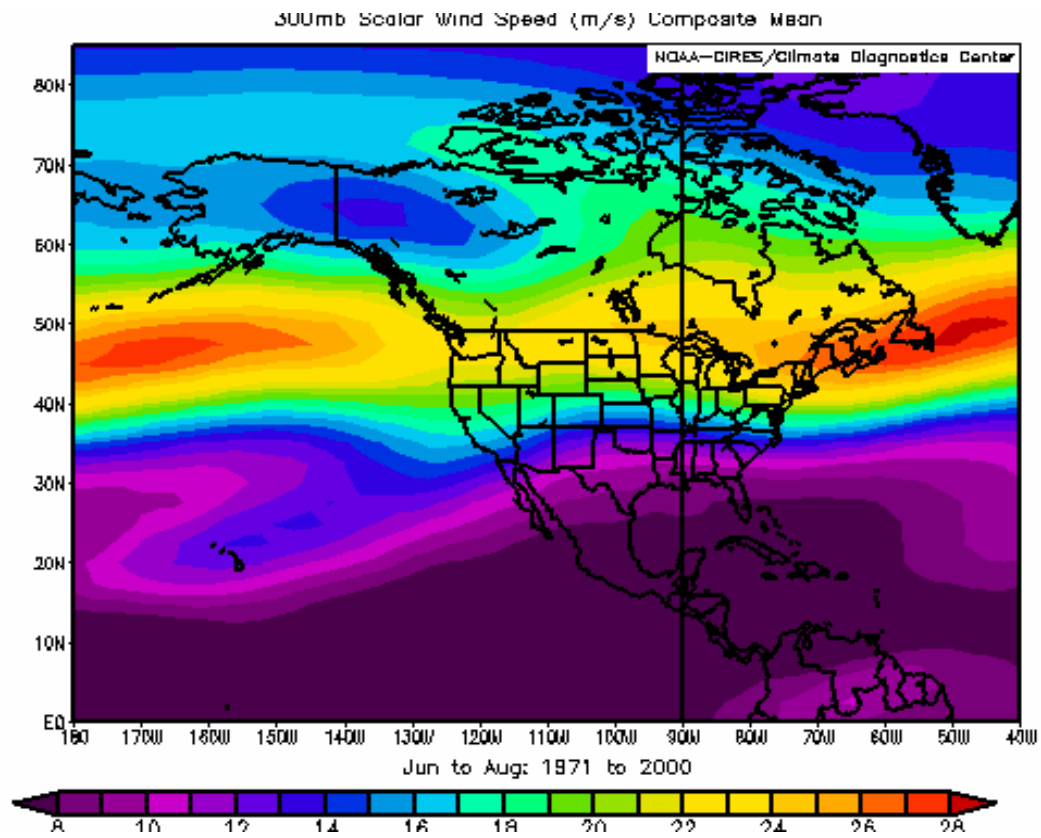
The jet stream location on each of these charts below is where the warm colors are.



**Figure 4: The summer jet stream during a cold summer, like 1992**

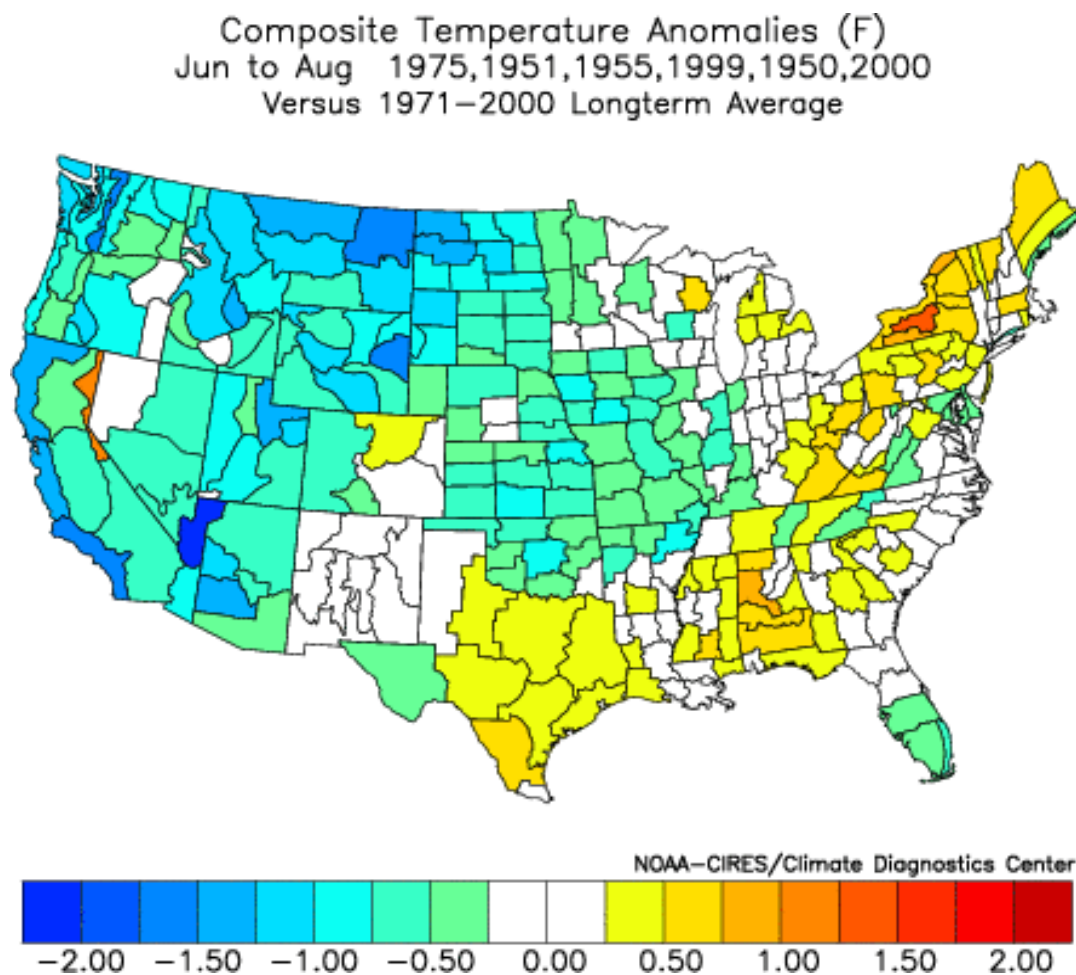


**Figure 5: The summer jet stream during a warm summer, like 2005**



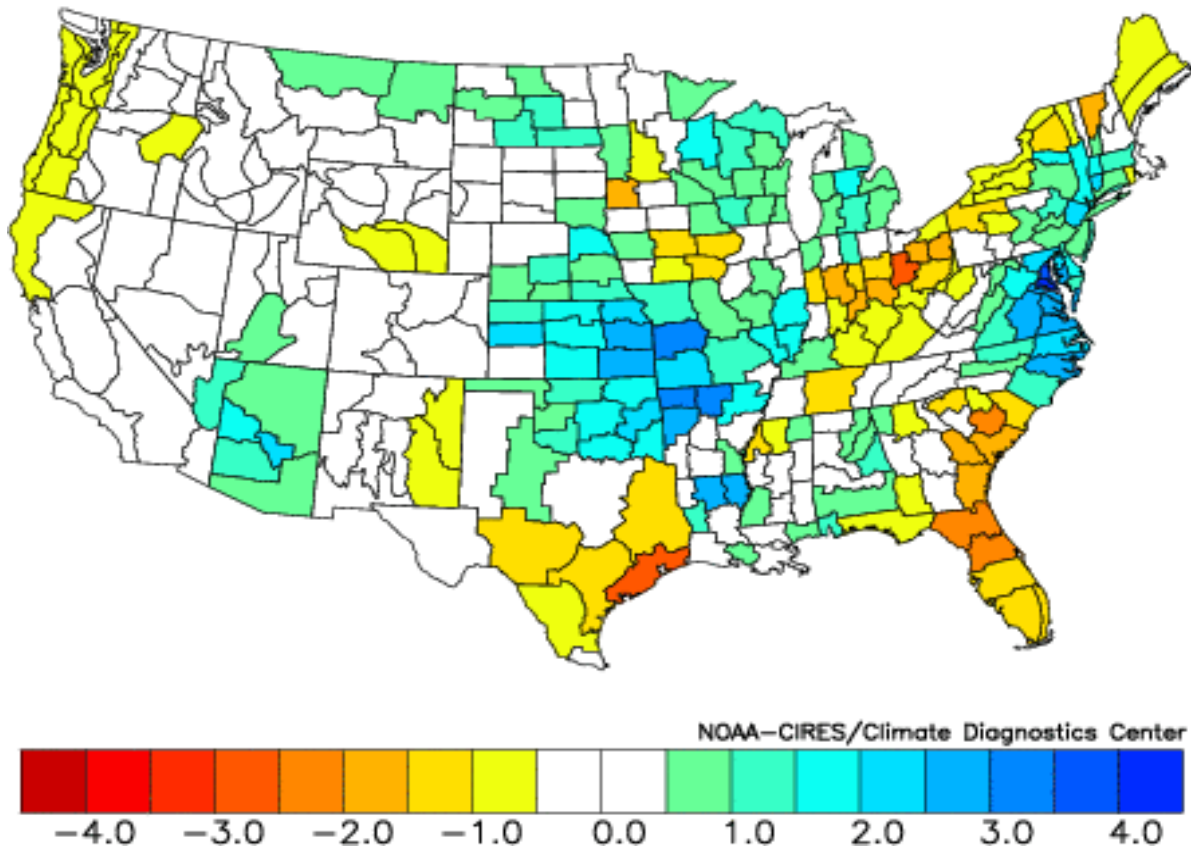
**Figure 6: The mean position of summer jet stream from 1971 to 2000**

## Analogs for Temperature and Precipitation based on a warm winter with a La Niña



**Figure 7: Summer temperature anomaly for a summer that follows a La Niña with a warm winter**

Composite Precipitation Anomalies (inches)  
Jun to Aug 1975,1951,1955,1999,1950,2000  
Versus 1971–2000 Longterm Average



**Figure 8: Summer precipitation anomaly for a summer that follows a La Niña with a warm winter**